Competency 1.14 **Occupational safety personnel shall demonstrate a working level knowledge of safety in the research and development, manufacture, use, transportation, testing, demilitarization, and disposal of explosives.**

1. Supporting Knowledge and Skills

a. Discuss the hazards associated with explosive material in terms of blast overpressure, fragments, thermal burns, and toxicity.

b. Identify the hazard classification of explosives and discuss the storage and compatibility requirements for each classification.

c. Discuss the major principles of personnel protection from explosives hazards and describe the application of each of these principles to explosives operations.

d. Describe the types, purpose, and application of personal protective clothing and equipment for explosives operations.

e. Discuss and demonstrate the ability to apply quantity-distance criteria to explosives operations.

f. Discuss the hazards associated with electrical equipment and installations in or near explosives operation and describe required control measures including appropriate hazard classifications.

g. Discuss the hazards associated with uncontrolled electrical sources such as static electricity and lightning, and describe the application of required controls such as:
   - Lightning protection
   - Non-sparking tools
   - Conductive footwear and floors
   - Equipment bonding and grounding

h. Discuss fire protection considerations for explosives operations.

i. Describe the role of hazard analysis and planning techniques for designing or evaluating explosives operations.

j. Discuss the proper facility design features for Department of Energy explosives operations.

k. Discuss the importance of the development, implementation, and maintenance of safe work procedures for explosives operations.

l. Discuss range safety considerations including required procedures and controls.

m. Describe the necessary precautions and procedures related to transportation of explosives.

2. Self-Study Activities (corresponding to the intent of the above competency)

Below are two web sites containing many of the references you may need.

Web Sites		
Organization	**Site Location**	**Notes**
Department of Energy	http://wastenot.inel.gov/cted/stdguido.html	DOE Standards, Guides, and Orders
OSHA	http://www.osha-slc.gov/	OSHA documents and search engine
U.S. House of Representatives	http://law.house.gov/cfr.htm	Searchable Code of Federal Regulations

Read DOE Order 5480.16A, *Firearms Safety*, Chapter IV.

Review DOE/EV/06194, Revision 7, *DOE Explosives Safety Manual*.

Read 29 CFR 1926, Subpart U, “Blasting and the Use of Explosives.”

EXERCISE 1.14-A Discuss the toxicity hazards associated with explosive material.

Read 49 CFR 173.2, “Hazardous Materials Classes and Index to Hazard Class Identification.”

EXERCISE 1.14-B Identify the explosives classes and divisions.

EXERCISE 1.14-C What is the maximum quantity of explosives (in pounds) that can be stored in a Class II magazine?

EXERCISE 1.14-D What is the American Table of Distances (a.k.a. Quantity Distance Tables) as relates to explosives?

EXERCISE 1.14-E Two major principles of explosives safety are limitation and control. What personnel and explosives limits does the *DOE Explosives Safety Manual* provide? You may use the manual as a reference.

Read OSHA *Technical Manual*, 2nd Edition, p. 12-7.

EXERCISE 1.14-F What type of full-body protective clothing is recommended by OSHA for use in a potentially explosive situation?

EXERCISE 1.14-G Using the *DOE Explosives Safety Manual* as a reference, give the formula for establishing the safe separation distance, and explain each factor.

EXERCISE 1.14-H Discuss the hazards associated with electrical equipment and installations in or near explosives operation and describe required control measures including appropriate hazard classifications.

EXERCISE 1.14-I Using the *DOE Explosives Safety Manual* as a reference, state the guidelines that govern shutdown of operations during an electrical storm.

EXERCISE 1.14-J Using the *DOE Explosives Safety Manual* as a reference, what is the minimum firebreak required around aboveground magazines or facilities processing or containing explosives?

EXERCISE 1.14-K According to the *DOE Explosives Safety Manual,* what are the three elements of hazard identification and communication that managers are required to complete before beginning explosives operations?

EXERCISE 1.14-L What does the *DOE Explosives Safety Manual* direct when using revolving doors as a means of escape from an explosives area?

EXERCISE 1.14-M When are explosives operating procedures required?

EXERCISE 1.14-N Explain why explosives safety procedures are required by the *DOE Explosives Safety Manual*.

EXERCISE 1.14-O What information does the *DOE Explosives Safety Manual* provide about hearing damage control during test firing, under the heading of “General Range Standards?”

Read DOE Order 1540.2, *Hazardous Material Packaging for Transport - Administrative Procedures*, Chapter XI, "Explosives Classifications."

EXERCISE 1.14-P Using the *DOE Explosives Safety Manual*, determine the minimum safe distance in feet between a UHF radiative power transmitter of 10,000 watts and electrical blasting operations.

EXERCISE 1.14-Q Using DOE Order 1540.2 as a reference, state the three requirements for transportation of new explosives.

3. Summary

Explosives present a potentially significant hazard to the public and DOE personnel if they are not handled and transported safely. Therefore, significant restrictions exist for the manufacture, storage, use, transportation, and disposal of explosives, and several agencies have regulations governing them. As a general rule, the key is to minimize the quantities of explosives and the personnel exposed to them while maximizing the distances from the danger and the escape options.

Several general provisions apply to any activity where explosive safety is a concern.

1. Only authorized and qualified persons should be allowed to handle and use explosives.
2. Any device capable of producing flame, head, or sparks is prohibited in or near explosives, or explosive storage areas.
3. No person is allowed to handle or use explosives while under the influence of intoxicating liquors, narcotics, or other dangerous drugs.
4. All explosives must be accounted for at all times and may not be abandoned.
5. No fire may be fought where the fire is in imminent danger of contact with explosives.
   (While fire is an obvious threat when dealing with explosives, it is important to remember that most accidental detonation of explosives result from stimuli other than fire.)
6. Blast containment precautions are required in congested areas, or in proximity to a structure or installation that might be damaged.
7. Every reasonable precaution including visual and audible warning signals, flags, and barricades must be used to ensure employee safety.
8. Blasting operations above ground should be conducted between sunup and sundown.
9. Precautions must be taken to prevent accidental discharge of electric blasting caps from induced current.
10. Packing materials previously containing high explosives must be burned at an approved location and not reused.
11. Buildings used for mixing blasting agents must meet particular specifications.

DOE adopted the hazard classification system recommended by the United Nations Organization (UNO), which defines types and severities of hazards for explosives. This system consists of nine classes for dangerous goods, with explosives in Class 1. This class further subdivides into divisions based on the character and predominance of the associated hazards, and the predominance of the associated hazards.

4. Exercise Solutions

EXERCISE 1.14-A Discuss the toxicity hazards associated with explosive material.

ANSWER 1.14-A Explosives materials, components, and materials used in explosives processing can be toxic when inhaled, ingested, or absorbed through the air. Skin contact can result in a skin rash, the most common effect from working with these materials. The *DOE Explosives Safety Manual* contains some precautions to minimize these hazards. These include good ventilation, protective clothing, and good personal hygiene practices.

EXERCISE 1.14-B Identify the explosives classes and divisions.

ANSWER 1.14-B

Explosives Classes and Divisions		
Class No.	**Division No. (if any)**	**Name of Class or Division**
None	.....	Forbidden explosives
1	1.1	Explosives (with a mass explosion hazard)
1	1.2	Explosives (with a projection hazard)
1	1.3	Explosives (with predominately a fire hazard)
1	1.4	Explosives (with no significant blast hazard)
1	1.5	Very insensitive explosives; blasting agents
1	1.6	Extremely insensitive detonating substances

EXERCISE 1.14-C What is the maximum quantity of explosives (in pounds) that can be stored in a Class II magazine?

ANSWER 1.14-C The maximum quantity of explosives that can be stored in a Class II magazine is 50 pounds.

EXERCISE 1.14-D What is the American Table of Distances (a.k.a. Quantity Distance Tables) as relates to explosives?

ANSWER 1.14-D The American Table of Distances refers to the American Table of Distances for Storage of Explosives as revised and approved by the Institute of the Makers of Explosives, June 5, 1964. It provides the acceptable distances in feet when storage is barricaded for separation of explosive magazines.

EXERCISE 1.14-E Two major principles of explosives safety are limitation and control. What does the *DOE Explosives Safety Manual* say about personnel and explosives limits? You may use the manual as a reference.

ANSWER 1.14-E "1. Explosives Limits: The quantity of explosives at an operating location shall be the minimum necessary to carry out the operation in a safe and efficient manner. When practical, this quantity shall be subdivided and adequately separated to prevent propagation of detonation. Supplies exceeding this minimum quantity shall be removed from the operating area.

In no case shall the quantity of explosives permitted in an operating building exceed the maximum permitted by the quantity-distance criteria. . . .

2. Personnel Limits: The number of personnel at an operating location shall be the minimum consistent with safe and efficient operation. In establishing personnel limits, the following principles shall be followed.

a. Jobs not necessary to the performance of a hazardous explosives operation should not be performed in the same location as the hazardous operation. Personnel not needed for the hazardous operations will not be allowed in hazardous locations.
b. Personnel limits shall allow for necessary casuals.

c. Sufficient personnel shall be available to perform a hazardous operation safely and, in the event of accident, to obtain help and aid the injured.
d. No person shall work alone performing explosives activities that have a high risk of serious injury. Prompt and easy communications with other employees shall be provided. Facility management shall specify which explosives activities may be performed alone." Chapter III, 1. & 2.

EXERCISE 1.14-F What type of full-body protective clothing is recommended by OSHA for use in a potentially explosive situation?

ANSWER 1.14-F Blast and fragmentation suits, vests, and clothing may be used in conjunction with bomb blankets and bomb carriers to reduce the dangers in very small detonations. They will not provide for hearing protection. (OSHA, *Technical Manual*, 2nd Edition, p. 12-7)

EXERCISE 1.14-G Using the *DOE Explosives Safety Manual* as a reference, give the formula for establishing the safe separation distance, and explain each factor.

ANSWER 1.14-G The formula is $D=KW^{1/3}$

- D is the distance in feet.
- K is a factor depending upon the risk assumed or permitted.
- W is the NEW (Net Explosive Weight) in pounds.

EXERCISE 1.14-H Discuss the hazards associated with electrical equipment and installations in or near explosives operation.

ANSWER 1.14-H Electrical equipment and installations provide many sources for concern when explosives are present. There is the danger of electrical sparks; short-circuits due to water infiltration, physical damage to the wiring, or exposed conductors or connectors; excessive surface temperature on electrical devices; and failure of electrical service lines.

EXERCISE 1.14-I Using the *DOE Explosives Safety Manual* as a reference, state the guidelines that govern shutdown of operations during an electrical storm.

ANSWER 1.14-I "The following guidelines should be used for shutdown of an operation during an electrical storm:

a. Process equipment containing explosives should be stopped as soon as safety permits.
b. When buildings or bays containing explosives are evacuated during periods of electrical storms, operations that cannot be shut down immediately should be manned by the minimum number of personnel required for safe shutdown. When the operation has been brought to a safe condition so that personnel can exit, evacuation of these remaining personnel should proceed.
c. Automatic emergency power equipment should be provided if electrical power is critical to an explosives operation during a power shutdown or interruption." Chapter II, 6.3.

EXERCISE 1.14-J Using the *DOE Explosives Safety Manual* as a reference, what is the minimum firebreak required around aboveground magazines or facilities processing or containing explosives?

ANSWER 1.14-J "A fire break at least 15 meters wide and free from combustible material should be maintained around each aboveground magazine or facility processing or containing explosives." Chapter VI, 5.1.

EXERCISE 1.14-K According to the *DOE Explosives Safety Manual,* what are the three elements of hazard identification and communication that managers are required to complete before beginning explosives operations?

ANSWER 1.14-K "Before beginning explosives operations, managers shall

a. Identify and maintain a current list of explosives and other hazardous material used in conjunction with their operations.
b. Determine the hazardous properties and toxicity of these materials through the use of the manufacturer's Material Safety Data Sheets (MSDS) or other information sources and through consultation with the facility industrial hygiene staff. For explosives without published toxicological data, guidance can be obtained through the DOE Toxic Materials Advisory

Committee (TMAC). Health hazard information must be communicated to employees who work with or generate hazardous materials.

c. Educate and train employees in the hazards and precautions required for handling explosives and materials used in conjunction with explosives operations. This training should be part of the employee training and qualification program specified in Chapter V." Chapter II, 1.6.

EXERCISE 1.14-L What does the *DOE Explosives Safety Manual* direct when using revolving doors as a means of escape from an explosives area?

ANSWER 1.14-L "A revolving door is acceptable if a secondary means of escape (with swinging doors) is provided at the same location. The revolving door must also be prevented from rotating at too rapid a rate in order to permit orderly exit of personnel." Chapter II, 2.2.6.c.

EXERCISE 1.14-M When are explosives operating procedures required?

ANSWER 1.14-M According to the *DOE Explosives Safety Manual*, "Before starting any operation involving explosives, operating procedures shall be written and approved." Chapter VII, 2.1.

EXERCISE 1.14-N Explain why explosives safety procedures are required by the *DOE Explosives Safety Manual*.

ANSWER 1.14-N "These requirements for procedures minimize the chances of an incident resulting from operations using outdated, inapplicable, or incomplete procedures, or from operations performed in violation of established practices." Chapter VII, 1.1.

EXERCISE 1.14-O What information does the *DOE Explosives Safety Manual* provide about hearing damage control during test firing, under the heading of "General Range Standards?"

ANSWER 1.14-O "Detonation of very large explosive shots, numerous smaller shots, or gun firings may result in hearing damage and may exceed the DOE allowable limits for impulse noise. Make a noise evaluation of these activities to ensure that adequate hearing protection is provided to those involved." Chapter II, 13.3.1.f.

EXERCISE 1.14-P Using the *DOE Explosives Safety Manual*, determine the minimum safe distance in feet between a UHF radiative power transmitter of 10,000 watts and electrical blasting operations.

ANSWER 1.14-P The safe distance is 600 feet. Chapter II, 13.3.5, Table II-2.

EXERCISE 1.14-Q Using DOE Order 1540.2 as a reference, state the three requirements for transportation of new explosives.

ANSWER 1.14-Q "New explosives, including explosive compounds, mixtures, or devices (hereinafter referred to as explosives) may be transported if they have been examined, classified, and approved for shipment by DOE." DOE 1540.2, Chapter XI, 2.a.